

# The Development of a Client Application for the Collaborative Social and Medical Services System

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## ABSTRACT

*This paper describes the design and implementation of a client application for the Baylor College of Medicine Teen Health Clinics. The application is the front end to the Collaborative Social and Medical Services System (CSMSS) under development by Baylor's Medical Informatics and Computing Research Program [8]. The application provides distributed access to an underlying object oriented database system. A process driven and patient centered design will provide staff members with a complete set of services, including forms for data entry and viewing, query, and access management to facilitate efficient and effective delivery of services. Role-specific interfaces will be supplied for clerks, nurses, nurse practitioners, physicians, and social workers. The client application is being designed using object oriented methodologies and technologies with the C++ programming language, and will operate within a Microsoft Windows operating environment utilizing Object Linking and Embedding for application interoperability.*

## INTRODUCTION

There is an appropriate and increasing desire in the United States to integrate social service activities with medical care, so that the whole person and the entire suite of problems he or she presents can be treated in a coordinated fashion. Parochial systems of health care, community development, family services, and job training too often produce fragmented support for the poor and the disadvantaged. We believe medicine as well as social services can benefit from improved communication and information management made feasible by high performance communications and computation across a network [1].

An integrated social service and medical care environment has been created within the Teen Health Clinics of the Baylor College of Medicine [8]. These clinics are staffed through the collaborative efforts of the Department of Obstetrics and Gynecology at Baylor, the Population Program within the College, and the Harris County Hospital District (HCHD), the fourth largest health services agency in the nation. There are five Teen Clinic sites currently dispersed throughout the city of Houston, Texas.

This work is based in part on our experience with a prototype application called the Virtual Chart System [3]. Like the BHCHP homeless project [4] and SuperChart [6], we use the client-server paradigm to support distributed communication. Like the patient-tracking system of the UCLA Children's Health Center [9], we use an object-oriented approach to the development of flexible user interfaces. Because our development effort is focused on support for both social and medical services in the Teen Health Clinics, we must support differing technological frames for different classes of users. The thrust of the project is to enhance clinical care and social service with products and systems that can be assembled using currently available technologies. A system with these goals must offer a spectrum of services to meet our end users' needs - allowing them to perform their job function more efficiently and with higher quality. This entails addressing issues such as data model design [2], data security mechanisms [5], and the client architecture.

This paper presents a scenario of how the CSMSS Client Application will be used in the clinic environment. We present a description of the methodologies and processes involved in the client specification,

design, and implementation. The paper closes with a description of our outstanding technology issues.

### SCENARIO

Nurse Jones arrives at the clinic, places her lunch in the refrigerator, pours a cup of coffee, and sits down at her desk. She logs into the CSMSS, checks her e-mail, notes the all-staff meeting in her personal appointment scheduler, and is ready to begin her work for the day.

The first activity of the day involves auditing yesterday's charts. Nurse Jones selects a patient from a list of all of the patients seen at this clinic on the previous work day for chart review. The patient's chart appears on the screen, with the summary of the last patient visit displayed. After scanning the summary page, Nurse Jones pages through the patient's chart, examining the data collected. It is apparent that Clerk Smith forgot to scan in the patient's immunization form. She creates an annotation that will appear with the patient's chart indicating the omission, and the responsible person. The message is automatically forwarded to Clerk Smith.

The telephone rings and interrupts Nurse Jones. The lab is calling with some test results for another patient. Nurse Jones locates the patient's name in the patient list and selects it for lab results entry. A form appears on the screen with the patients pending lab tests. Nurse Jones enters the results on the form. Since the lab result was positive, Nurse Jones sends a form letter, using her word processor, to the patient asking her to call the clinic as soon as possible.

Nurse Jones takes a pen-based computer with her to see the patient in the exam room. She scans the patient's chart summary, which is already displayed on the screen, and notes that the patient is here for a 3 month oral contraceptive check-up. Nurse Jones notices that the patient's weight seems high, so she requests a tabular summary of the patient's weight and blood pressure over time. Nurse Jones then starts a "3-month follow up" session with the system.

Nurse Jones enters the exam room and asks the patient about how she feels and if there are any side effects related to use of oral contraceptives. With the pen, she checks off these observations on the form displayed on the screen. During the conversation, Nurse Jones notices a bruise on the patient's arm, and asks her about it. The patient seems worried, and reluctant to talk about the bruise. Nurse Jones will

send an appropriate electronic mail message to the social worker, after the session is concluded.

Nurse Jones reviews her observations and upon completion her orders/services form is displayed. She checks off the review and records that she counseled the patient on weight control and proper use of the oral contraceptives. She schedules a 6 month follow-up, using the appointment scheduler. She then makes an appointment for the patient to see the social worker, prints a new appointment card for the patient, and continues seeing patients.

### METHODOLOGY & CURRENT SPECIFICATION

A combination of object oriented methodologies have been used in the analysis and design of the CSMSS Client Application. A number of investigations were conducted to obtain the requirements. The investigations were accomplished by interviewing staff members, observing the clinics' operation, examining patient charts, analyzing the clinic Medical Protocols document, and holding focus group meetings with subsets of the clinic staff.

Based on the information obtained through the investigation described above, the following roles were established: clerk, nurse, nurse practitioner, physician, and social worker. Within each role we listed the operational tasks each user might perform. By specifying the tasks, we were able to establish a work flow process. For example, a nurse might audit charts or record a patient's medical history. Each patient specific task was further broken down by patient problem. For example, a sickle cell anemia test is only listed during a patient's first visit and tests for gonorrhea and chlamydia are listed as options whenever a patient comes in for a pregnancy test.

The CSMSS is designed to be extensible in order to accommodate changes in health care and social services delivery as well as evolving software standards and technology. The application has been subdivided into modules, each of which provides a unique service, thereby reducing the amount of functional coupling. As a result, future services can be added to the application without affecting existing services. This ability to "drop in" new modules at any time plays an important role in the extensibility and ultimate longevity of the CSMSS Client Application.

Currently, the client application consists of a Session Manager, a Form Manager, a Patient Browser, and an Access Manager, all of which operate within the Inte-

grated Desktop Environment, as described below. Each module communicates with the CSMSS Server Application by way of the Client Protocol Framework, depicted in Figure 1. In addition, the modules communicate with the Session Manager which maintains the desktop environment.

### Integrated Desktop Environment

The integrated desktop is a computer based working environment for the CSMSS user. It provides an operating environment for both third party applications and the CSMSS Client Application, as well as a fundamental set of services. The goal of the desktop environment is to integrate the CSMSS with third party applications by providing an efficient and intuitive interface. To achieve this goal, we identified applications needed by the user, basic services needed by the desktop environment, and CSMSS tools needed in the desktop environment.

**Applications.** Third party applications include a word processor, a spreadsheet, an electronic mail system, and a scheduling system.

**Basic Services.** A set of “basic services” was defined for the desktop environment which includes folders, a wastebasket, an access control mechanism, and a search utility.

The folder is merely a container of desktop objects, including other folders. It offers the ability to organize or group a collection of objects.

The wastebasket supports the disposal of desktop objects. It manages the lifetime of disposed objects, i.e., should they be disposed of immediately, should they live in the wastebasket for some time, or should they be returned to the desktop environment. It is important to understand that the wastebasket does not remove objects from the CSMSS Server Repository, it only supports the removal of objects from the desktop.

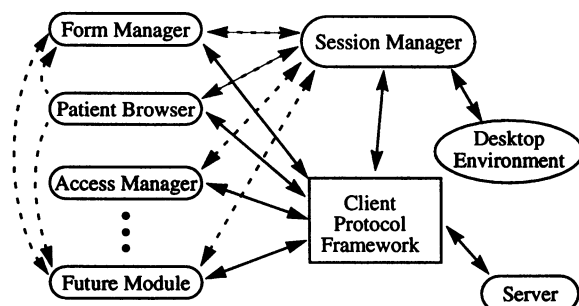


Figure 1. The CSMSS Client Architecture

The access control mechanism provides security for the desktop environment. It prevents unauthorized use of the desktop by requiring users to log into and out of the environment. This mechanism also enables/disables certain system features on a per user/role basis, by requesting authentication from the CSMSS Server Application [8].

A search utility provides the desktop environment with a search capability. It is utilized to locate desktop objects within the desktop environment.

**Tools.** A set of tools needed in the desktop environment include the Session Manager, Form Manager, Patient Browser, and Access Manager.

**Session Manager** - provides the user with the initial interface to the CSMSS. Presentation of the interface is based on a user role. The Session Manager is responsible for logging users into and out of the CSMSS, launching various client modules, and storing all CSMSS specific desktop objects.

When a user logs into the desktop environment, the Session Manager is launched, and connects the user to the CSMSS Server Application. This process includes retrieving user specific configuration information, restoring the desktop to its previous state, and presenting the user with any pending notices that need to be addressed.

When a user logs out of the system, the Session Manager stores the current state of the desktop environment, cleans off the desktop, and terminates all connections with the CSMSS Server.

**Form Manager** - provides a process driven (task oriented) mechanism for entering and viewing patient data which is entered into or viewed from a form. Access to the patient data is provided via a query mechanism built into the form. The Form Manager provides two basic types of forms including the View Form and Report Form.

The View Form supports patient data entry, viewing and query by example. Data entry includes typed input from a keyboard or hand written input from an electronic pen & pad device. Type checking and range validation services are also provided. Data viewing and query are complementary operations. To view data a query is executed explicitly by the user or implicitly by the system based on a user action or the current process. The results of a query are displayed in the current form or a new form depending on the context.

The Report Form provides “fill in the blank” queries. This type of form allows the user to perform more powerful queries than the example based queries possible with the View Forms by providing access to aggregate information, result sorting, and report layout customizing.

Instantiation of the Form Manager is provided by the Session Manager. The Session Manager provides the Form Manager with a patient object and the current process (if needed). The Form Manager presents the user with a list of the forms needed for the process and by default opens the first form in the list. The user has the flexibility to override the current process if needed.

An example is shown in Figure 2. The user has selected “Initial Visit” from the Session Manager. This action prompted the Session Manager to instantiate a Form Manager. There is no patient context for the Form Manager since the patient has not been defined in the system. The current task or process is presented to the user by way of a list of forms (defined in the process “Initial Visit”). The Form Manager presents the first step of the process by opening the Patient Registration form.

**Patient Browser** - provides access to patient lists (see Figure 2). The primary patient list is the Master Patient Index (MPI) maintained by the CSMSS Server. The MPI is available to all CSMSS users who have access to the Patient Browser. Users may access the MPI to create any number of private lists of patients. If necessary, users may search the MPI for patients using demographic information as search criteria. The Patient Browser also offers access to patient registration and patient chart information.

**Access Manager** - provides an interface to the CSMSS Access Management Facility [5].

## FUTURE WORK

Future work on the CSMSS Client Application includes the investigation of a combination of data entry techniques and offering new services to the user to enhance the current CSMSS. Data acquisition and providing for user mobility are the two most challenging aspects of application development in this domain. Two data entry methods currently being investigated include voice input and hand written input.

Voice input will allow hands off operation. Currently, there are several commercial systems with vocabular-

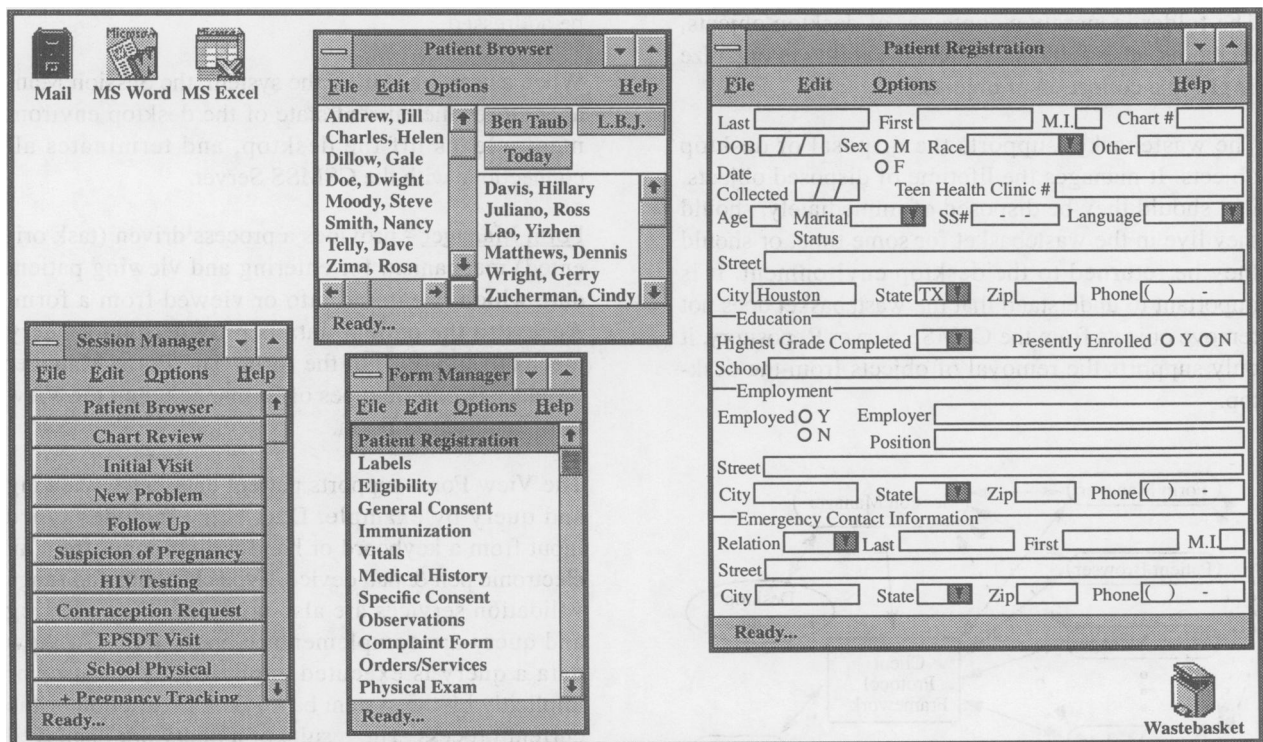


Figure 2. The Collaborative Social and Medical Services System's Client Application Desktop Environment

ies exceeding 50,000 words [7]. Handwriting recognition offers a comparable challenge. While voice will enable the hands off computing, in some instances, speech is not appropriate or even possible. For example, while a patient is being interviewed by a physician, a physician may need to communicate information to both the computer and the patient. Thus, writing with an electronic pen device may be an appropriate alternative. Both voice recognition and handwriting recognition technologies are improving rapidly and represent significant potential for future development.

Additions required for CSMSS Client Application evolution include an Object Browser and a Forms Creator. The Object Browser will provide ad hoc browsing of objects defined in the CSMSS Data Model [2] (e.g., Patients, Encounters, and Problems). Users will be able to choose a root object from which to start browsing. For example, a user will be able to select a patient object. From the patient object, the user will be able to explore patient data by traversing links between component objects. The Forms Creator will offer users the ability to create forms that meet their specific needs. They will be able to define processes by establishing a sequence of forms to be displayed, and they will be able to assign access to a given form.

### CONCLUSION

The CSMSS Client Application utilizes current technologies and standards to provide an integrated solution to support social services and clinical care. By taking advantage of high speed computing and communications across networks we are able to provide a complete set of services allowing our users to perform their job more efficiently and with higher quality. Our design has emphasized on abstractions that increase the flexibility of the system, permitting quick development and enhancement of user interfaces, and allowing users to develop their own views of data; at the same time preserving the integrity of patient medical data in a distributed, collaborative environment.

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